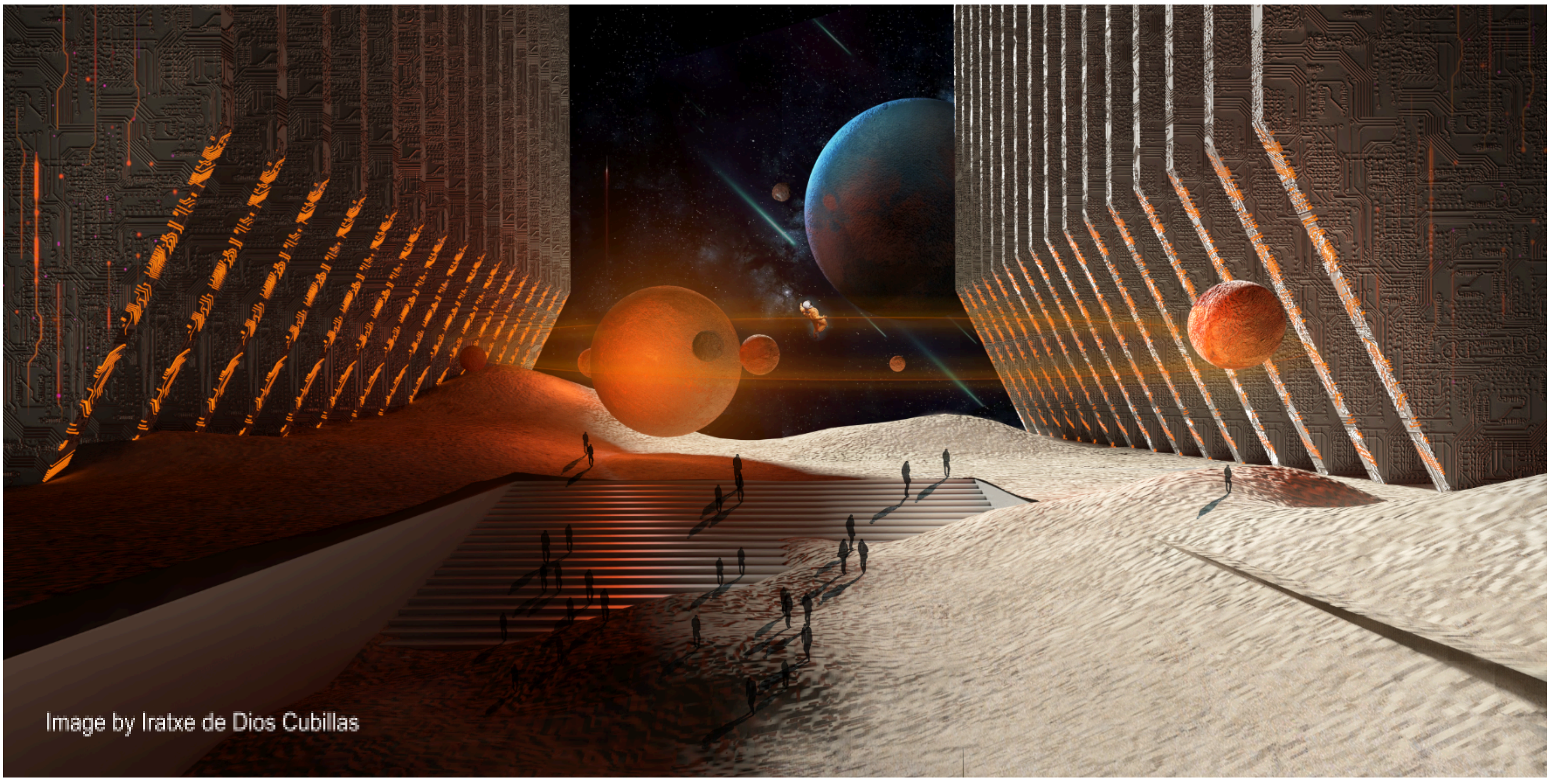


Keep you uP^{h}Dated days
CAB-INTA
18th-19th December 2024

Contents

Welcome

Welcome once again to the **Keep You uPhDated Days CAB-INTA 2024**, the third edition of our in-house conference dedicated exclusively to predoctoral researchers conducting innovative studies at the Centro de Astrobiología (CAB) and the Instituto Nacional de Técnica Aeroespacial (INTA). Building on the success of previous editions, this year promises another insightful and enriching experience. Our program will feature 26 presentations and 2 posters spanning key areas such as Astrophysics and Astrochemistry, Planetology and Habitability, Molecular Evolution and Life Sciences, as well as Instrumentation and Space Missions. In response to the valuable feedback from previous events, we have designed a schedule that blends technical discussions with engaging non-technical activities, ensuring a dynamic and comprehensive experience for all participants.

This year, we are excited to highlight the following sessions. First, the Roundtable**: *Internationalization and Research Career***. A stimulating discussion on internationalization in research careers, featuring professionals with extensive global experience who will share insights and strategies for enhancing the international scope of our academic and scientific trajectories. We are pleased to have Mª Paz Zorzano Mier (Evaluation Committee), Laura Sánchez García (Postdoc), and Antonio Martínez Henares (Predoc) from CAB. They will be available to answer questions and provide valuable perspectives on their respective career stages and expertise.

We will also have a workshop: ***Corporal Expression – Overcoming Stage Fright.*** Conducted by *La Asociación para la Investigación e Integración de la Salud Emocional* (AIISE), this theatrical workshop will explore techniques to develop confidence and poise in public presentations, helping participants overcome stage fright and improve their stage presence.

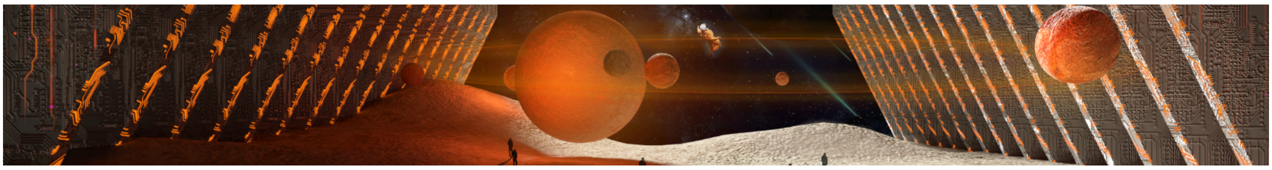
And finally the Workshop: ***Mental Health – Acknowledging Impostor Syndrome***. Led by María García from Cámara de Madrid. This workshop will address the impact of impostor syndrome on research careers, offering practical tools to recognize and effectively manage these feelings.

We are confident that these activities, alongside the scientific presentations, will provide a comprehensive experience that fosters both academic and personal growth for all attendees. We also encourage you to make the most of the coffee breaks and rest periods to connect with your colleagues, exchange ideas, and learn more about the fascinating research being conducted by your peers. These informal moments are excellent opportunities to expand your network and spark interdisciplinary collaborations!

We extend our heartfelt gratitude to all presenters and attendees for their invaluable contributions to the success of this conference. We look forward to sharing an inspiring and memorable event with you!

Fuen, Víctor, Bruno, Carmen and Carlota (the organizing committee).

Programme



Wednesday 18th December

08:30 – 08:45	Registration and welcome
08:45 – 10:15	**Session 1 - Vera Rubin**
8:45 – 9:00	**Leonor Arriscado:** Unveiling the correlation between the UV 2175Å bump, PAH emission, and gas-phase metallicity at cosmic noon: a multi-wavelength study with JWST, VLT, and Keck
9:00 – 9:15	**Gonzalo J. Carracedo:** How lollipops could be good for HARMONI
9:15 – 9:30	**Patricia Fernández-Ruiz:** Analysis of sulphur chemistry in the envelope of hot corinos
9:30 – 9:45	**Miguel Arribas Tiemblo:** The ordeal of being preserved: An analysis of biomarker survival in the Martian surface.
9:45 – 10:00	**Carlota Prieto Jiménez:** Cosmic Origins: The Galaxy of the Big Three Dragons in the Epoch of Reionization
10:00 – 10:15	**Carla Alejandre Villalobos:** Modelling the polymerization and replication of primordial RNA at clay-water interfaces in early Earth
10:15 – 10:45	Coffee break
10:45 – 12:00	**Session 2 - Yuri Gagarin**
10:45 – 11:00	**Andrés Megías Toledano:** A fast machine learning tool to predict the composition of astronomical ices from infrared absorption spectra
11:00 – 11:15	**Oscar Gamallo Palomares:** Desarrollo de una aplicación de monitorización sistemas de navegación por satélite
11:15 – 11:30	**Jaime Alonso Hernández:** Circumstellar chemistry in X-ray emitting AGB stars
11:30 – 11:45	**Pablo L. Finkel:** From bio to geo: understanding lipid biomarker degradation through a gradient of lithification

11:45 – 12:00 **David San Andrés:** First detection in space of the high-energy isomer of cyanomethanimine: H2CNCN

12:00 – 13:30 Round table: *Internationalization and Research Career*

- MªPaz Zorzano Mier (Evaluation committee)
- Laura Sánchez García (Postdoc)
- Antonio Martínez Henares (Predoc)

13:30 – 14:30 Lunch break

14:30 – 15:45 **Session 3 - Harrison Schmitt**

14:30 – 14:45 **David Haasler:** Spatial distribution of phosphorus carriers in galactic and extragalactic star-forming regions

14:45 – 15:00 **Raúl Rodriguez-Veloso:** Propiedades ópticas de aerosoles observadas por el sensor de radiación y polvo (RDS) de MEDA en el cráter Jezero, Marte

15:00 – 15:15 **Aitana Tasa Chaveli:** Tracing the evolutionary stage and the chemical history of starless cores through HCN, HNC, and N2H+ isotopic ratios

15:15 – 15:30 **Federico Mansilla Nuñez:** Potential Existence of a Volcanically Driven Hydrothermal System beneath Cerberus Fossae (Mars)

15:30 – 15:45 **Jose Luis Gragera Más:** Stellar Encounters with the Beta Pictoris System

15:45 – 17:15 Workshop - Corporal expression: overcoming stage fright

Thursday 19th December

08:30 – 10:00	**Session 4 - Rosalind Franklin**
8:30 – 8:45	**Carmen Blanco Prieto:** How do we really know what was happening billions of years ago?
8:45 – 9:00	**Alicia Rodríguez Moreno**: Viral evolution under simulated microgravity
9:00 – 9:15	**José Henrique Costa Pinto Souza:** Blowing Star Formation Away in Active Galactic Nuclei Hosts. I. Observation of Warm Molecular Outflows with JWST MIRI
9:15 – 9:30	**Andres Garcia**: Production Rates of Cosmogenic Nuclides in the Mars Sample Return collection
9:30 – 9:45	**Raúl Castellanos Sánchez**: Infrared observations of Westerlund 1: Tracing massive star evolution
9:45 – 10:00	**Raquel Murillo Ojeda:** White dwarfs with infrared excess within 100 pc using Gaia DR3 and the Virtual Observatory
10:00 – 11:00	Coffee break - option to attend a talk about the research done at CAB
11:00 – 12:15	**Session 5 - Baruch Blumberg**
11:00 – 11:15	**Antonio Martínez-Henares:** The impact of winds, jets and multiplicity on disks around massive stars: the case of MWC 349A
11:15 – 11:30	**Víctor Muñoz:** Metagenomic characterization of a Pyrenean ice cave
11:30 – 11:45	**Julián José Miranzo Pastor:** The Missing Sulfur Problem
11:45 – 12:00	**David Ramos Somolinos:** Nuevas técnicas experimentales para la caracterización electromagnética de materiales aeroespaciales
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12:15 – 13:15	Workshop - *Mental health: acknowledging impostor syndrome*
13:15 – 14:45	Christmas lunch! 🎄

Abstracts

Session 1 - Vera Rubin

Wednesday 8:45-10:15

8:45 – 9:00
Leonor Arriscado
Astrophysics & Astrochemistry
CAB

Unveiling the correlation between the UV 2175Å bump, PAH emission, and gas-phase metallicity at cosmic noon: a multi-wavelength study with JWST, VLT, and Keck

Cosmic noon, corresponding to redshifts of z~2-3, marks a pivotal era in the Universe's history, when it was approximately 2 to 3 billion years old. During this relatively brief period, galaxies formed nearly half of their present-day stellar mass, driven by intense star formation activity fuelled by the interplay of gas inflows and outflows. Thus, this epoch offers a unique opportunity to study the mechanisms shaping galaxy evolution.
Dust attenuation is a key factor during cosmic noon, with the UV 2175Å bump—a broad absorption feature—providing insights into the properties of interstellar dust. The bump is thought to arise from PAH molecules, whose abundance and emission are influenced by the metallicity of galaxies. Exploring the connection between metallicity and the UV bump at cosmic noon can shed light on the composition and evolution of interstellar dust.
In this study, we investigate gas-phase metallicities of galaxies at z~2.1-2.7 using spectroscopic observations from Keck/MOSFIRE. We employ the PypeIt software to reduce spectroscopic data and derive metallicities from nebular emission lines, including [NII], Hα, Hβ and [OIII]. These measurements will be complemented by JWST/MIRI and VLT/MUSE data to probe the relationship between gas-phase metallicity, PAH emission, and the UV 2175Å bump. This multi-wavelength approach highlights the critical role of metallicity in shaping dust properties and demonstrates the synergy of space- and ground-based observatories in unravelling the complex processes driving galaxy evolution at cosmic noon.

9:00 – 9:15
Gonzalo J. Carracedo
Instrumentation & Space Missions
CAB

How lollipops could be good for HARMONI

HARMONI is the first light visible and near-IR integral field spectrograph for the Extremely Large Telescope (ELT). To achieve its optimal image quality, HARMONI needs to perform pointing error measurement by means of two guide probes. Each guide probe is a robotic arm with a shoulder-elbow stage that is optically equivalent to two periscopes connected together. Since any systematic positioning error of the shoulder-elbow motors will result in a measurement error of the pointing error itself, an appropriate corrective model is necessary. While in previous architectures of the guide probes a corrective model based on Zernike polynomials was deemed enough, it has been shown to be a poor choice for the new shoulder-elbow architecture. In this talk I will introduce a new set of corrective model basis functions called the Lollipop Expansion, in what ways it is better than the previous Zernike expansion, and some RayZaler simulations with the new corrective model in action. I will also explore some of its challenges in terms of numerical stability and some strategies to address them.

9:15 – 9:30
Patricia Fernández-Ruiz
Astrophysics & Astrochemistry
CAB

Analysis of sulphur chemistry in the envelope of hot corinos

When the core of a low-mass protostar progressively collapses and heats the infalling envelope, a region of compact, hot and dense dust and gas appears. These regions are known as hot corinos, and they present a very rich chemistry, with dozens of complex organic molecules detected. Therefore, studying the chemistry of hot corinos is key to understand the overall star and planet formation processes.

On the other hand, while sulphur is an important element that takes part in the development of biological systems, we only account for a fraction of the total cosmic abundance of sulphur in dense molecular gas. For this reason, we are focusing on the chemistry of sulphur bearing species found in hot corinos, confident it can shed some light on the problem of the missing sulphur.

Our goal is to determine the amount of gaseous sulphur as well as the chemical composition of the sulphur budget in the envelopes of these warm objects. We have observed Class 0 protostars HH 212 and NGC 1333 IRAS4A, which are known to harbor hot corinos, in the 7, 3, 2 and 1 mm wavelengths. We search for transitions of 25 S-bearing species and perform rotational diagrams to find their column densities, rotational temperatures and abundances.

9:30 – 9:45
Miguel Arribas Tiemblo
Planetology & Habitability
CAB

The ordeal of being preserved: An analysis of biomarker survival in the Martian surface.

Biomolecules face a wide range of stressors within the Martian surface; from highly damaging UV and ionizing radiation, to oxidative stress arising from the Martian regolith itself. This last source of stress, the Martian regolith, can also assist in the preservation of biomarkers located within it, mostly through the attenuation of UV radiation.

We have assessed both UV-B and regolith induced damage in a wide range of biomarkers and microorganisms, from proteins, to carotenoids and cyanobacteria. More oxidative Martian regolith simulants tend to lead to diminished preservations and to hindered growth, and all regoliths appear to protect similarly from UV-B induced damage.

Throughout the presentation I will explain the most promising biomarkers we have found, how their suitability varies based on the parameters to be optimized.

9:45 – 10:00
Carlota Prieto Jiménez
Astrophysics & Astrochemistry
CAB

Cosmic Origins: The Galaxy of the Big Three Dragons in the Epoch of Reionization

The James Webb Space Telescope (JWST) is revolutionizing our understanding of the formation and evolution of galaxies, particularly during the first one billion years after the Big Bang, with a special focus on the Epoch of Reionization (EoR), when the first galaxies were formed.

In this presentation, I will focus on an example of a galaxy from this epoch: the galaxy B14-65666 (also known as the Big Three Dragons), which existed when the Universe was 740 million years old (redshift $z = 7.15$). Galaxies from this time are characterized by their intense star formation and their gravitational interaction with other galaxies, including merger processes that influence their evolution. To study this galaxy, we used multi-wavelength data, combining observations from JWST and the Atacama Large Millimeter/submillimeter Array (ALMA). This combination allows for a detailed analysis of the galaxy's physical properties, such as its star formation, gas and dust content, and the dynamic processes associated with its evolution.

10:00 – 10:15
Carla Alejandre Villalobos
Molecular evolution & Life Sciences
CAB

Modelling the polymerization and replication of primordial RNA at clay-water interfaces in early Earth

The RNA world hypothesis suggests that life was originated in an environment in which informational and functional RNA molecules were able to self-replicate through the activity of RNA ribozymes. It is likely that those already complex ribozymes emerged thanks to a step-wise, ligation-based modular evolution of short RNA sequences. Nevertheless, even modular evolution of RNA required the presence of an up-to-now unknown replicative mechanism to guarantee the availability of copies of specific RNA sequences in which selection could act. In this context, we introduce a theoretical and computational framework called EarlyWorld to model the non-enzymatic polymerization of ribonucleotides and the template-dependent replication of primordial RNA molecules at the interfaces between the aqueous solution and a clay mineral supplied by its interlayers and channels, an environment known to favor RNA polymerization. This conceptually simple *in silico* model allows us to test how environmental conditions could affect the length and fidelity of RNA copies, as well as to study how the efficiency of the RNA replicative phenomenology could depend on other parameters of the system, such as the size of the genetic alphabet. Our theoretical and numerical results show that efficient polymerization and accurate replication of single-stranded RNA polymers, sufficiently long to acquire basic functions (>15 nt), were possible at clay-water interfaces in early Earth, provided the physico-chemical environment exhibited an oscillatory pattern of large amplitude and a period compatible with spring tide dynamics. This reinforces the potential importance of the Moon in the origin and early evolution of life. Moreover, the versatility of our framework enables comparisons between different genetic alphabets, showing that a four-letter alphabet –particularly when allowing non-canonical base pairs, as in current RNA– represents an optimal balance of replication speed and sequence diversity in the pathway to life.

Session 2 - Yuri Gagarin

Wednesday 10:45-12:00

10:45 – 11:00
Andrés Megías Toledano
Astrophysics & Astrochemistry
CAB

A fast machine learning tool to predict the composition of astronomical ices from infrared absorption spectra

Interstellar dust is composed of micrometric particles of silicates and carbon, usually covered by an ice layer of varying composition. The main species of this ice layer is water, followed by carbon monoxide, carbon monoxide, methanol, methane and ammonia, but it may contain more complex organic compounds.

Surface chemistry in interstellar dust plays a key role in the chemistry on the interstellar medium, and it is believed to be important for the formation of complex organic molecules that lead to the formation of prebiotic molecules in solar-type systems. However, measuring the composition of dust ices requires very sensitive astronomical observations, which is difficult with ground based telescopes.

Fortunately, current and future observations carried out by James Webb Space Telescope (JWST) allow to observe absorption features of ices with high sensitivity and spectral resolution. Despite the good quality of the data, determining the quantitative composition of the ices with precise ratios is not trivial, and current models or tools that allow to estimate it require a detailed individual study with significant computation times.

In this talk I will present a machine-learning tool called AICE (Automatic Ice Composition Estimator). It is based on artificial neural networks and allows to predict the fractional composition and temperature of astronomical ices given its absorption spectrum in the infrared range from 2.5 to 10 microns. In order to train the model, we have used hundreds of laboratory experiments of ice mixtures available from public databases. Once trained, the algorithm is very fast (less than 1 second) and our results show a good performance, with typical errors of 3 %. This would allow us to make fast and automatized predictions on the major ice components of astronomical observations.

11:00 – 11:15
Oscar Gamallo Palomares
Instrumentation & Space Missions
INTA

Desarrollo de una aplicación de monitorización sistemas de navegación por satélite

La demanda de mayor precisión en posicionamiento y tiempo que llevamos experimentando durante las últimas décadas ha generado que los grandes bloques de piases desarrollen su propio sistema de posicionamiento satelital, ampliando el abanico de opciones que se pueden usar para este propósito. De estas constelaciones la más conocida es GPS, pero aquí en Europa tenemos nuestra propia constelación: Galileo. Este proyecto, enfocado en equipar a Europa con un sistema propio e independiente del resto, lleva ya varios años activo y proporcionando servicio a la sociedad, sin embargo el 1 de Julio del 2019 los datos enviados desde los satélites Galileo empezaron a fallar, generando que el sistema estuviera fuera de servicio durante una semana.
Este hecho pasó mayoritariamente desapercibido para los usuarios, debido a que cuando falla se usa directamente la información de GPS. Este incidente evidenció la necesidad de monitorear las señales

de los diferentes satélites de forma externa al propio programa Galileo. Así, han surgido diferentes proyectos de seguimiento y monitorización de los satélites que verifican la información que ofrecen directamente las agencias.
En el Centro de Seguridad Espacial estamos desarrollando una primera versión de nuestra propia herramienta que nos dé la capacidad de realizar ese control de manera autónoma, comprobando los datos proporcionados por las diferentes agencias contra los ofrecidos por los receptores. En dicha aplicación se podrán seguir parámetros como la posición de los satélites y su propagación en el tiempo, su estado de salud, las bandas en las que trabaja, la potencia de la señal y el error de posicionamiento.

11:15 – 11:30
Jaime Alonso Hernández
Astrophysics & Astrochemistry
CAB

Circumstellar chemistry in X-ray emitting AGB stars

In this presentation, I will show the preliminary results from our ongoing project to characterise the chemical properties of the circumstellar envelopes (CSEs) around AGB stars with X-ray emission (xAGBs). This study is based on a sensitive line search for HCO+ emission with the IRAM 30m MRT.

AGB stars are among the most important astrochemical sources, CSEs offer a wide range of physical conditions and a spectacular gradient of chemical abundances along the envelope, resulting in amazing astrochemical laboratories. Although the basics of chemistry in AGB CSEs are relatively well understood, it is still not well known how binarity affects the chemistry of the envelopes. This is the case of the recently discovered xAGBs, in which the X-ray emission is likely produced in accretion processes in binary systems, opening a new window to study the X-ray induced chemistry in AGB CSEs.

This work is focus on the first characterisation of the chemistry in xAGBs. We detected HCO+ emission lines in the carbon-rich xAGB T Draconis. Our analysis, which includes radiative transfer analysis and chemical modelling, indicates that the HCO+ abundance in T Draconis ($1.5\text{-}3.0\times10^{-8}$) is at least one order of magnitude larger than expected in carbon-rich AGBs, in which a firm detection of HCO+ remained elusive until some years ago due to the low abundance of this molecule.

The empirically constrained HCO+ abundance in T Draconis is in very good agreement with the HCO+ abundance predicted by our chemical model including the internal X-ray emission, pointing out that X-ray induced chemistry is the most feasible explanation of the HCO+ abundance enhancement. We also detected other X-ray sensitive molecules (e.g. HNC, HC3N), although they are less sensitive to X-ray emission and their estimated abundance enhancements are lower than in HCO+.

11:30 – 11:45
Pablo L. Finkel
Molecular evolution & Life Sciences
CAB

From bio to geo: understanding lipid biomarker degradation through a gradient of lithification

If life ever developed on Mars, simple cell-like organisms would have likely emerged during the late Noachian (4.1 - 3.5 billion years ago), an era known for potentially habitable conditions. These organisms could have gone extinct at the dawn of the Amazonian era (~ 3 billion years ago), characterized by hyperaridity and geological paucity. Soon after extinction, the molecular remains of such organisms would initiate a process of progressive degradation triggered in part by radiation and surface oxidants. Consequently, unequivocal biomarkers transform into abiotic-like molecules of simpler structure, whose origin is ambiguous. Until more complex remnants are found, it is imperative to understand the way biomarkers degrade, as they may have on early Mars.

Hypothetical Martian cells would likely develop a membrane. On Earth, all cells have membranes whose major components are lipids. This grants them a relevant property for astrobiology: ubiquity. Furthermore, lipids are highly geostable, meaning their recalcitrant hydrocarbon skeletons allows them to retain their chemical structure over long timescales, despite degradation-favouring conditions. Nevertheless, lipids are not spared from significant molecular alteration in the billion-year timescale. For that reason, understanding the governing mechanisms of early degradation in lipid biomarkers may help elucidate the origin of simpler organics on Mars.

We here assess lipid degradation through a lithification gradient. We analyzed lipids from three sample types: a growing microbial mat, a lithifying microbial mat in the process of petrification, and a fully lithified microbialite. These samples reflect a transition from the biosphere to the geosphere, representing early stages of organic matter alteration that might have taken place on primitive Mars. With the goal of identifying solid biomarker targets, we hope to provide insights into which lipids have potential to retain their structural identity over time.

11:45 – 12:00

David San Andrés
Astrophysics & Astrochemistry
CAB

First detection in space of the high-energy isomer of cyanomethanimine: H2CNCN

How life originated on Earth is one of the great enigmas that still persists in astrobiology. One of the most accepted hypothesis is the so-called RNA-world, which points to this macromolecule as the main trigger for primordial biological activity. Numerous prebiotic chemistry experiments have shown that RNA building blocks can be synthesised from much simpler molecules, with nitriles (organic species with the −C≡N functional group) playing a dominant role. The clearest example is found on hydrogen cyanide (HCN), whose oligomerization reactions appear to be the major route towards the formation of adenine (H5C5N5), one of the purine nucleobases of RNA and DNA. A crucial step triggering this process concerns the initial formation of HCN dimers (H2C2N2), having their two most stable representatives, the E- and Z-isomers of C-cyanomethanimine (HNCHCN), already been detected in the interstellar medium (ISM).

In this talk, I will present the first detection in the ISM of N-cyanomethanimine (H2CNCN), the stable dimer of HCN of highest energy and the most complex organic molecule reported in space containing the prebiotically relevant NCN backbone. The detection is supported by the identification of a plethora of rotational transitions towards the Galactic Center G+0.693-0.027 molecular cloud, through its recently improved ultra-high-sensitivity spectral survey using the Yebes 40 m and IRAM 30 m radio telescopes. This cloud is the only interstellar source showing the three cyanomethanimine isomers thus far. On the basis of a LTE analysis, we derived a total molecular abundance with respect to H2 of (2.1±0.3)×10-11, which sets N-cyanomethanimine as one of the least abundant species detected thus far in this region. This demonstrates how the growing efforts in achieving a greater sensitivity on the observational data are pushing the limits of molecular species detectability in space.

Session 3 - Harrison Schmitt

Wednesday 14:30-15:45

14:30 – 14:45
David Haasler
Astrophysics & Astrochemistry
CAB

Spatial distribution of phosphorus carriers in galactic and extragalactic star-forming regions

The study of the chemical composition of star- and planet-forming regions is a fundamental step to understand how prebiotic chemistry could have proceeded in the early Earth. In particular, phosphorus (P) is a critical element for the development of life as we know it given its key role in several biomolecules, although the formation mechanisms of P-bearing molecules in the interstellar medium remain poorly understood.
The sensitivity of current radio interferometers like the Atacama Large Millimeter/submillimeter Array (ALMA) allows us to search for faint molecules and map their spatial distribution in great detail. We have used high spatial resolution (~50 au) observations carried out with ALMA to search for two P-bearing molecules, phosphorus nitride (PN) and phosphorus oxide (PO), towards IRAS 16293-2422, the prototypical analog of the precursor of the Solar System. These observations target three sets of rotational transitions of PN and PO, allowing us to perform a multi-transition analysis to study the excitation of these molecules. The observations show that the emission of PN and PO arises from shocked material traced by the emission of the shock tracers sulfur monoxide (SO), and sulfur dioxide (SO2).
The comparison between the current observational evidence and available chemical models indicates that the chemistry of P-bearing species is mainly regulated by shocks, which contribute to desorbing the phosphorus locked on the dust grains. The models suggest that a yet unknown P-carrier is desorbed from the dust grain surface, and subsequent gas-phase reactions would then lead to the formation of PN and PO.

14:45 – 15:00
Raúl Rodríguez-Veloso
Instrumentation & Space Missions
INTA

Propiedades ópticas de aerosoles observadas por el sensor de radiación y polvo (RDS) de MEDA en el cráter Jezero, Marte

Aerosols on Mars are a primary element for studying the interaction between the solar radiation and the atmosphere and surface. Depending on properties such as aerosol number density, particle radius, or refractive index, the impact of the aerosols can provide positive or negative radiative feedbacks on the dynamics of the atmosphere. Previous studies have revealed large temporal and spatial variability in the aerosol optical properties, emphasizing the necessity for continuous monitoring of these properties throughout the day and at multiple locations. To address these measurements, the Radiation and Dust Sensor (RDS) is part of the Mars Environmental Dynamics Analyzer (MEDA) payload onboard of the Mars 2020 rover Perseverance. RDS instrument compromises two sets of 8 photodiodes (RDS-DP) and a camera (RDS-SkyCam). One set of photodiodes is pointed upward, with each one covering a different wavelength range between 190-1200 nm. The other set is pointed sideways, 20 degrees above the horizon, and they are spaced 45 degrees apart in azimuth to sample all directions at a single wavelength. The analysis of these observations with a radiative transfer model allow us to fit aerosol parameters such as the aerosol opacity at different wavelengths or the aerosol particle radius.

15:00 – 15:15
Aitana Tasa Chaveli
Astrophysics & Astrochemistry
CAB

Tracing the evolutionary stage and the chemical history of starless cores through HCN, HNC, and N2H+ isotopic ratios

Starless cores are dense and cold regions of molecular gas without compact luminous sources, where stars may eventually be formed. They are the seed of star formation, arising from concentrations of gas and dust along the filamentous structure of molecular clouds. One way to understand their dynamics is through the study of molecular isotopic ratios such as deuterium fractionation (D/H) or 14N/15N. D/H is predicted to increase when a core evolves towards the onset of gravitational collapse and therefore is widely used to trace the evolutionary stage of starless cores. On the other hand, 14N/15N allows us to link properties in the interstellar medium and Solar System objects. We used IRAM 30m data to constrain the D/H isotopic ratios of HCN, HNC, and N2H+, as well as the 14N/15N ratio of HCN and HNC, in a sample of 23 cores located in the star-forming regions of Taurus, Perseus and Orion. During this talk, these isotopic ratios will be proven as key tools to trace the chemical history of starless cores.

15:15 – 15:30
Federico Mansilla Nuñez
Planetology & Habitability

Potential Existence of a Volcanically Driven Hydrothermal System beneath Cerberus Fossae (Mars)

There is compelling evidence of lava-ice interactions in the Cerberus-Athabasca region (Cassanelli & Head 2018; Mansilla Nuñez et al. 2024), involving enormous quantities of fluids (Kim et al. 2014).
The source area of Cerberus Fossae is also one of the most tectonically active regions on Mars (Giardini et al. 2020) and features significant volcanic activity (Rivas-Dorado et al. 2022). This area is surrounded by basins that are known to contain substantial amounts of subsurface water (Watters et al. 2024).
Additional evidence supporting the presence of a hydrothermal system includes a thermal anomaly that aligns with the local topography near the scarps. This anomaly has been previously described as an aerothermal system (Antoine et al. 2011).
Building on this prior research, we analyzed features in the region using CRISM data. Our observations identified the presence of CO_2 ices, H_2O ices, as well as hydrated and altered minerals.
The cumulative evidence suggests the existence of an active hydrothermal system, driven by volcanic activity and sustained by subsurface ice or water reservoirs in the region.

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15:30 – 15:45
Jose Luis Gragera Más
Astrophysics & Astrochemistry
CAB

Stellar Encounters with the Beta Pictoris System

Beta Pictoris (BP) is an A-type star hosting a planetary system with two massive planets and a debris disk featuring a complex double structure. Additionally, the presence of absorption lines with short-term variability in the Beta Pictoris spectrum has been interpreted as cometary material falling into the star. To better understand the origin of the exocometary activity in the Beta Pictoris system, we have conducted an investigation into the role of stellar flybys. These passing stars can perturb objects within the Beta Pictoris cloud of comets, altering their periastron distances and potentially injecting them into the inner stellar system, thereby triggering exocomet showers. Using precise astrometry data from the Gaia mission, supplemented by radial velocity data from other surveys, we reconstructed Beta Pictoris's stellar encounter history by tracing the orbits of nearby stars within detailed galactic potential models. The catalogue of stellar encounters with the Beta Pictoris system provides a foundation for our simulations aiming at studying the effects of such encounters on BP’s Oort cloud and their potential correlation with cometary activity in the inner regions of the system.

Session 4 - Rosalind Franklin

Thursday 8:30-10:00

8:30 – 8:45
Carmen Blanco Prieto
Astrophysics & Astrochemistry
CAB

How do we really know what was happening billions of years ago?

The universe’s history began 13.8 billion years ago, and over that vast span of time, it has undergone numerous transformations. Our group focuses on studying galaxies from the ‘Epoch of Reionization,’ which occurred roughly a billion years after the Big Bang. This pivotal period marked the universe’s transition from a dark, neutral state to a transparent, ionized one, enabling the first stars and galaxies to illuminate the cosmos. But how can we study objects from that long ago?

In this talk, I will briefly explore how advances in telescopes like JWST and ALMA, combined with cutting-edge science, allow us to peer into this distant past. Using our work on the galaxy A1689-zD1 as an example, I’ll highlight the role of gravitational lensing and explain how we analyze raw telescope data to uncover the properties of a galaxy, that on a bigger picture, help us understand the role of galaxies in the early Universe and how they contributed to its formation and evolution.

8:45 – 9:00
Alicia Rodríguez Moreno
Molecular evolution & Life Sciences
INTA

Viral evolution under simulated microgravity. Authors: Rodríguez-Moreno A and Lázaro E

The main objective of the Experimental Evolution Studies with Viruses and Microorganisms group (Molecular Evolution Department of the Centre of Astrobiology) is to understand the dynamics and molecular basis of biological adaptation under controlled conditions in the laboratory. In this context, our laboratory performs evolution experiments with an RNA bacteriophage (Qβ) that infects the bacterium Escherichia coli to analyze the evolutionary pathways followed by the virus when it is confronted with environmental changes. Among the selective pressures studied are included some that could be of relevance for the evolution of the first replicators that populated the early Earth and others that could be typical of space and extraterrestrial environments. Among the latter are desiccation, freezing-thawing cycles, microgravity or increased doses of ultraviolet radiation.

The work presented here contains the results obtained when studying the survival and evolution of the virus under simulated microgravity conditions using a 3D-clinostat provided by the Department of Systems and Natural Resources of the Universidad Politécnica de Madrid. Our results show that the virus replicates worse in microgravity than in standard gravity conditions. However, upon propagation of the virus in semisolid medium for ten serial transfers in the 3D-clinostat, it was possible to obtain populations that better cope with this situation. The genetic characterization of the adapted populations allowed us to identify a specific mutation (C2011A; change T222N in the A1 protein of the virus) that seems to be responsible for the observed phenotypic changes. This mutation favors virus entry into bacteria, making it easy for the virus to initiate infections. The results are compatible with lower diffusion of the virus and with differences in the growing of the bacteria when infections are carried out under microgravity conditions. Further experiments are necessary to distinguish between these two possibilities.

9:00 – 9:15
José Henrique Costa Pinto Souza
Astrophysics & Astrochemistry
CAB

Blowing Star Formation Away in Active Galactic Nuclei Hosts. I. Observation of Warm Molecular Outflows with JWST MIRI

Feedback from Active Galactic Nuclei (AGN) plays a fundamental role in shaping massive galaxies by suppressing star formation and regulating the growth of their host galaxies. AGN driven outflows, occurring across multiple gas phases, can redistribute gas within galaxies and significantly influence star formation. A relatively unexplored phase is that of warm molecular gas, for which spatially resolved observations only became possible with the James Webb Space Telescope (JWST). We use JWST Mid-Infrared Instrument medium-resolution spectrometer (MIRI-MRS) observations of the radio-loud AGN host UGC 8782 to study the warm molecular and ionized gas emission and kinematics. The data reveal outflows in the inner 2 kpc, seen in low ionization (traced by the [Ar II] 6.99 μm emission) and in warm molecular gas (traced by the H2 rotational transitions). We find a maximum mass-outflow rate of 4.90 ± 2.04 M ⊙ yr-1 at ~900 pc from the nucleus for the warm outflow (198 K ≤ T ≤ 1000 K) and estimate an outflow rate of up to 1.22 ± 0.51 M ⊙ yr-1 for the hotter gas phase (T > 1000 K). These outflows can deplete the entire nuclear reservoir of warm molecular gas in about 1 Myr. The derived kinetic power of the molecular outflows leads to coupling efficiencies of 2%–5% of the AGN luminosity, way above the minimum expected for the AGN feedback to be effective in quenching the star formation.

9:15 – 9:30
Andres Garcia
Planetology & Habitability
INTA

Production Rates of Cosmogenic Nuclides in the Mars Sample Return collection

The present-day surface and atmosphere of Mars has been bombarded for tens of millions to billions of years by the incident energetic Galactic Cosmic Rays (GCR), Solar Cosmic Rays (SCR) and their secondary particles. As a result of the impact of these high energy particles on the rocks of the surface of Mars cosmogenic nuclides are produced. The question remains, how many new isotopes have been produced by this interaction?
The Perseverance rover is acquiring a collection of Martian samples at Jezero Crater. We have studied the production yields of four igneous rocks which were characterized by Perseverance rover during the crater floor campaign to showcase the differences in cosmogenic production. Here we use a well-tested Monte-Carlo model, to study the effects of space radiation on rocks, specifically we focus on the cosmogenic production rates of isotopes of elements up to Z=28 (Ni) in the igneous rocks sampled at Jezero crater floor. The simulation considers a beam of high energetic neutrons, whose energies expand from 4 to 8000 MeV, and a cylindrical target with Martian composition with 50cm of radius and 55cm long.
H and He have the highest production yields. The analysis of carbon and nitrogen isotopes in Martian samples is relevant because their isotopic ratios can reveal past biological activity, helping to assess whether Mars once supported life. If we assume the sample has an initial carbon content of 10 ppm with initial δ13C of -20‰, then due the production of cosmogenic isotopes δ13C can reach 10 ‰ and 40 ‰ for 1.4 Gy and 2.5 Gy, respectively.
This work showcases the impact of cosmogenic nuclides on the interpretation of the isotopic ratios on planetary materials and in particular its impact on C and N which are critical elements for life.

9:30 – 9:45
Raúl Castellanos Sánchez
Astrophysics & Astrochemistry
CAB

Infrared observations of Westerlund 1: Tracing massive star evolution

Westerlund 1, one of the most massive stellar clusters in our galaxy, offers a unique laboratory for exploring the evolution of massive stars. Its young age and diverse stellar population, spanning vastly different evolutionary stages, provide invaluable insights into how these stars develop and interact within a dense environment. However, studying this cluster in the optical range is particularly challenging due to the vast amount of interstellar dust that obscures much of its light. Infrared observations provide a unique advantage, allowing us to peer through the dust and uncover hidden aspects of the cluster.
Through our observations, we have identified the main sequence stars within Westerlund 1, enabling us to more accurately constrain its age and provide a clearer context for interpreting the evolutionary paths of its massive stellar population, including those driven by single and binary evolution. These findings help piece together the puzzle of massive star evolution, where many connections are still missing.

9:45 – 10:00
Raquel Murillo Ojeda
Astrophysics & Astrochemistry
CAB

White dwarfs with infrared excess within 100 pc using Gaia DR3 and the Virtual Observatory

White dwarfs (WDs) are one of the most common objects in the Galaxy. A significant fraction of white dwarfs are not isolated but are found in systems with stellar or substellar objects or may have a disc.
We will show the white dwarfs with infrared excess we identified at 100 pc. The origin of the infrared excesses can be attributed to two causes: The presence of a low mass, cool companion or the existence of a circumstellar dust disk.
We used Gaia DR3 spectroscopic coefficients and GaiaXPy to obtain JPAS synthetic photometry. We complemented JPAS photometry with infrared photometry gathered from astronomical archives. Using VOSA we fitted the SEDs to identify flux excess at infrared wavelengths and then we made a two-body SED fit to the candidate systems. During the process, WDs with contamination were discarded using Aladin.
In this talk, we will present the results and analysis of the white dwarf with infrared excess catalogue.

Session 5 - Baruch Blumberg

Thursday 11:00-12:15

11:00 – 11:15
Antonio Martínez-Henares
Astrophysics & Astrochemistry
CAB

The impact of winds, jets and multiplicity on disks around massive stars: the case of MWC 349A

Massive young stars are surrounded by a rotating disk of gas and dust, which will be the birthplace of planetary systems. The central star grows in mass by accreting materials from the disk. These accretion processes imply the removal of angular momentum through the launching of winds and jets. However, their launching mechanisms and their impact on the gas within the innermost regions of these objects remain vastly unknown. In addition, massive stars are typically detected as multiple systems, which could also have an effect on their disks' structure and evolution. During my PhD, we have studied the innermost circumstellar medium of massive stars through a multi-wavelength approach using observations from different facilities: the radio domain with ALMA, the near-infrared with the VLTI, and the optical with the GTC. The main focus of the project has been the study of jets and winds launched from the circumstellar disk through the study of the radio emission, particularly the Hydrogen Radio Recombination Line masers from the massive star MWC 349A. We have spatially resolved the Radio Recombination Line maser emission for the first time thanks to the capabilities of ALMA. In this talk, I will give a brief and comprehensive overview of this and the other results that we have obtained in these years.

11:15 – 11:30
Víctor Muñoz
Molecular evolution & Life Sciences
CAB

Metagenomic characterization of a Pyrenean ice cave

Ice caves are an important example of ecosystems that have not yet been thoroughly explored from a microbiological point of view due to their geographical isolation. Using next-generation sequencing (NGS), the taxonomic composition and metabolic capabilities of an ice cave located on the Spanish border of the Pyrenees have been characterized. In this cave, several rooms with perennial ice (~5,000 years old) were found. Samples from these massive ice bodies, along with two samples of seasonal ice and two additional samples from a river flowing through the cave, were collected, and the taxonomic composition of the microbial communities was analyzed. In similar caves, biomineralization processes have been documented. In this cave, several mineral formations resembling bacterial shapes were observed. Consequently, metabolic pathways potentially related to this biomineralization process were investigated. The results obtained highlight the unexplored microbial and metabolic diversity present in the cryosphere, with relevance for fields such as the biotech industry, paleoclimatic reconstruction, and the study of habitability in extreme environments.

11:30 – 11:45
Julián José Miranzo Pastor
Astrophysics & Astrochemistry
CAB

The Missing Sulfur Problem

Sulfur is the tenth most abundant element in the Universe, with a cosmic abundance of 10^-5. This value has been measured in the solar system and is also compatible with the sulfur observed in the low-density interstellar medium (ISM), where all the sulfur appears to be in the gas-phase. However, the denser ISM, such as molecular clouds, and the early stages of star formation do not show the same gas-phase abundance, but around two orders of magnitude lower. Here arises the known as the Missing Sulfur Problem, which tries to explain where the sulfur in these denser regions is hidden. One of the most accepted hypothesis claims that sulfur is locked in H2S ices in the denser ISM, but the observation of the corresponding H2S transitions in the ice has been extremely challenging, to the point where ice-H2S has not been observed to the date. To loop around this problem, H2S observations have been proposed in the inner core of protostars, where higher temperatures sublimate the ices and, with them, the H2S gets to the gas phase. On the other hand, H2S ices photodissociation leads to the formation of OCS ices, which will be in the gas phase as well as the H2S in the warm core of protostars. The final goal is to study how the H2S/OCS ratio varies in a set of 24 Class 0/I protostars from the Perseus Molecular Cloud. We also compare observations with chemo-MHD simulations in order to examine the factors that may affect the variations of the H2S/OCS ratios, and to understand where the missing sulfur might be hidden.

11:45 – 12:00
David Ramos Somolinos
Instrumentation & Space Missions
INTA

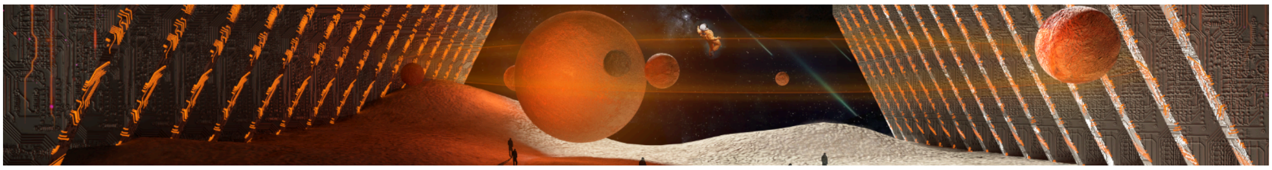
Nuevas técnicas experimentales para la caracterización electromagnética de materiales aeroespaciales

Gran parte del desarrollo tecnológico implementado dentro de la industria aeroespacial se ha centrado en la investigación de nuevos materiales que ofrezcan prestaciones superiores a las de los empleados históricamente (esencialmente materiales metálicos), siendo un claro ejemplo de esto los materiales compuestos, que combinan la flexibilidad, bajo peso, buenas propiedades mecánicas y facilidad de moldeo de los polímeros junto con las propiedades magnéticas y eléctricas de materiales de refuerzo a base de carbono y/o ferritas.

Por otro lado, la producción y proliferación de nuevos dispositivos eléctricos y electrónicos tienen como consecuencia el desplazamiento progresivo de las comunicaciones hacia frecuencias más altas y mayores anchos de banda, con el consiguiente incremento en el uso de ondas electromagnéticas de alta frecuencia. A su vez, esto genera niveles de campo electromagnético nunca antes alcanzados, haciendo necesario investigar y caracterizar, no solo las prestaciones mecánicas y térmicas de los materiales mencionados anteriormente, sino también su comportamiento desde el punto de vista de su interacción con los campos electromagnéticos. Esto hace que el diseño e implementación de instalaciones, así como el desarrollo de nuevos métodos de medida que ayuden en la caracterización de estos nuevos materiales sean muy necesarios y útiles.

En este contexto, la motivación de esta tesis es investigar nuevas técnicas experimentales de caracterización de las propiedades electromagnéticas de materiales, tanto aeronáuticos como espaciales, para adaptarse a las especificaciones que cada tipo de ensayo pueda requerir a través del estudio de las diferentes configuraciones de medida.

Este trabajo ha sido realizado en el Laboratorio de Electromagnetismo Computacional y Aplicado (CAEM-Lab) del INTA, que es un actor singular a nivel nacional y de primer nivel europeo en la investigación y en la prestación de servicios de caracterización electromagnética de materiales, medida de antenas, medida de firma radar y simulación electromagnética, dentro del sector aeroespacial.



Posters

P1 **Estudio de reflectores para calibración radiométrica de los sistemas SAR del satélite PAZ**
María Moragrega Langton
Instrumentation & Space Missions
INTA

P2 **Design of a Broadband Electromagnetic Characterisation System for Aerospace Materials at Extreme Temperatures**
Alicia Auñón Marugán
Instrumentation & Space Missions
INTA